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FREIA AND KOMPAS, THE CENTRAL PLANNING BUREAU'S NEW GENERATION OF MACRO-ECONOMIC POLICY MODELS: A REVIEW ARTICLE

BY

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1 INTRODUCTION

The Netherlands has a long-standing tradition in the use of empirical macro-economic models in policy making. It is now almost half a century ago that Professor Tinbergen presented the first model for the Dutch economy at the General Meeting of the Dutch Economic (and Statistical) Society (Tinbergen, 1936). The model consists of 24 equations and its coefficients have been estimated using annual data over the period 1923–1933. Already in those days Tinbergen derived practical policy recommendations from his model. He suggested a number of measures in order to enhance employment without unduly hampering the balance of payments.

After the Second World War Tinbergen became one of the founders and the first director of the Central Planning Bureau. In the 1950's and 1960's this Bureau used a number of versions of an annual Keynesian demand model for its policy analysis. This first generation of models served both for short-term prediction and for cyclical policy simulations.

In these short-term models unemployment is used as the sole cyclical indicator and productive capacity is exogenous. However, when unemployment rose considerably in the 1970's, this structure was no longer adequate. A second generation of models was subsequently developed at the Central Planning Bureau in which both the utilization rate of capital and the unemployment rate act as cyclical indicators. With Van den Beld's (1968) *C*yclical-*S*tructural model as predecessor, the main models of this generation are the successive versions of VINTAF. In VINTAF the usual Keynesian demand equations determining total expenditure are combined with a clay-clay vintage model with labour-saving-embodied technical progress and a fixed capital-output ratio. This supply block determines labour demand and productive capacity. The utilization rate of capital follows from the confrontation of total demand and productive capacity. The endogeneity of productive capacity labels VINTAF as a medium-term model.

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VINTAF explains the rise in unemployment mainly by the excess of the growth rate of real wages over the rate of technical progress. This excess causes the economic life of capital equipment to decline so that old, labour-intensive vintages are progressively scrapped and replaced by new vintages, demanding less labour. Wage restraint ensues as a natural policy recommendation from the model in order to curb this process.

The 1970's showed sharply increasing and volatile interest rates and by the end of that decade the government budget deficit had risen to an unprecedentedly high level which, apart from unemployment, became the major concern of macro-economic policy. However, the Dutch models mentioned above do not pay much attention to monetary phenomena. Strikingly, VINTAF does not include monetary variables at all. Therefore, the need emerged for a new generation of macro-economic policy models, comprising a full description of the monetary sector of the economy. In 1981 both the Netherlands Bank and the Central Planning Bureau published elaborate monetary models based on a closed set of sectoral balances (Fase, 1981; see also Fase, 1984; Den Haan, Hasselman and Okker, 1981). Then, in September 1982 in a note on medium-term economic policy by a committee of high-ranking civil servants (Central Economic Committee, 1982), which was prepared for the formation of the new government, the Central Planning Bureau showed the first simulation results of the model FREIA. The main message of these simulations was that austerity in public spending would lead to a fall in demand and hence to less employment in the short run, yet resulting in higher economic growth in the long run.

FREIA is an annual model which links an adapted version of the Central Planning Bureau's monetary model mentioned above to a model of the real sector conformable to the structure of VINTAF. The latter makes FREIA a medium-term model and the successor of VINTAF. Although the first results of FREIA were shown in the autumn of 1982, more than a year passed before a full description of the model became available (Hasselman, Okker and Den Haan, 1983). At the same time the Central Planning Bureau published a quarterly model, KOMPAS, with more or less the same structure and properties as FREIA (Van den Berg, Don and Sandee, 1983). Meanwhile the Netherlands Bank had also constructed a quarterly model, MORKMON, (Fase, 1982; De Nederlandsche Bank, 1984) linking its monetary model to an own model of the real sector.

This article reviews the new Central Planning Bureau's models, FREIA and KOMPAS, against the background of the present discussions on both the practical use of macro-economic models in policy analysis and on the theory of macro-economic modelling. The organization of the article is as follows. The next section summarizes the structure of both models. Then, section 3 discusses some characteristics of the models when used for policy analysis and gives a comparison with other models. Subsequently, section 4 comments upon some further aspects of the models in the light of the theoretical and empirical literature. The final section presents the conclusions.

2 THE STRUCTURE OF FREIA AND KOMPAS

2.1 *FREIA*

FREIA, the German goddess of love and beauty, and the mistress of ceremonies in the Walhalla, is used by the Central Planning Bureau as an acronym for a model with which the *f*inancial and *r*eal sector of the *e*conomy can be *a*nalysed in an *i*ntegrated manner (see also Okker, Den Haan and Hasselman, 1983). The model consists of 355 equations, about 40 of which are behavioural. The coefficients are estimated using annual data over the period 1954–1975 for the real sector and over the period 1957–1978 for the financial sector. The statistical estimation does not play a dominant role in determining the parameter values of the model: other considerations such as economic plausibility and previous experience preponderate in assessing a number of coefficients. Moreover some equations, mainly in the field of the public sector, describe institutional relationships which determine the parameter values. The minor importance of econometric methodology in constructing the model is illustrated by the fact that its description does not report any statistics.

As mentioned in the introduction, FREIA's submodel for the real sector essentially has the same structure as VINTAF. A synthetic series for the capital stock is composed by adding up vintages of investment in equipment over their economic life. Technical progress is completely labour-saving, implying a constant marginal capital-output ratio so that productive capacity is, in principle, proportional to the capital stock. The labour-saving technical progress is partly embodied, *i.e.* connected with specific vintages which are of a clay-clay type, and partly disembodied, allowing all vintages to become less labour-intensive over time. Of course, these assumptions on the exogenous 'manna from heaven' technical progress and its parameter values play a crucial role in the working of the model. The rates of embodied and disembodied technical progress have constant values of 3.77% and 1.57% respectively in the period 1951–1975 and are supposed to decrease in later years. Disembodied technical progress is set to zero after 1978 and the rate of embodied technical progress comes down to 3% in 1982.

The capital stock and labour-saving technical progress determine the full-capacity labour demand. This relationship is also influenced by the number of effective working hours of labour. Accordingly the effective working time of equipment affects the proportionality of the capital stock and productive capacity. In this way FREIA may simulate different aspects of the reduction of working time.

Aside from technical deterioration, scrapping of old vintages occurs because of economic obsolescence. The scrapping condition, determining the economic life-span of capital equipment, compares the real labour costs with the output of a vintage. Vintages are scrapped if output no longer covers labour costs.

The amount of labour that enterprises actually want to employ will be less

than full-capacity demand if production takes place below full capacity. Yet the relationship that connects capacity labour demand with potential labour demand only partly reflects the influence of fluctuations in the utilization rate as enterprises keep a cyclical labour reserve. Actual labour demand by enterprises results from weighing potential demand and labour supply, the latter being determined mainly by demographic factors. The weights ensue from a disequilibrium approach for the labour market, wherein periods of tension on that market supply obtain a large weight. However, in periods of excess supply, as has been the case in recent years, effective labour demand almost equals potential demand. This disequilibrium approach also yields a measure of frictional unemployment.

This concludes the description of the supply block of FREIA, which endogenizes both cyclical indicators. Capacity utilization follows from the confrontation of productive capacity and total expenditure and unemployment from labour supply and actual demand.

With the exception of some special features, total expenditure is described by the usual Keynesian demand equations. Private consumption follows from a relatively simple equation with disposable wage and other income, and the real interest rate as determinants. Wealth effects do not play a role in the consumption function.

FREIA pays more attention to investment. With respect to investment in equipment of enterprises a distinction is made between new investment and replacement investment. The determinants of new investment are (expected) profitability of new vintages and expected sales. The calculation of profitability uses parameter estimates of the supply block on expected economic life-span and technical progress. In calculating profitability taxes are subtracted from the profits, so that the influence of both monetary and fiscal factors, such as specific policy measures in order to stimulate investment, is modelled along this line. Replacement investment is equal to the scrapping of old vintages and for investment in industrial buildings. FREIA assumes complementarity with investment in equipment. Inventory formation is mainly determined by final sales and is also influenced by the real interest rate and a measure of tension on the market for short-term bank loans. It is remarkable that, according to the model, neither actual profits nor cash flow have a direct impact on investment.

The export equations are simple and traditional. Exports of goods are determined by a measure of world trade and by an export price differential representing competitiveness. Exports of services are proportional to exports of goods.

As compared to exports the treatment of imports in FREIA is much more elaborate. The model disaggregates total imports into 8 different categories, 6 of which are endogenous. All import equations have the same structure with a scale variable, a price differential and, in some equations, the utilization rate as determinants. Much attention is paid to the construction of the scale

variable, which is in most cases final demand reweighted according to the share of the imported good under consideration. The component parts of the price differential are reweighted similarly. A noticeable aspect of the disaggregation is that separate equations are estimated for imports of energy, which of course gained much importance in the 1970's, and for imports of services by households. This expenditure on tourism also showed a considerable growth in the 1970's due to the high income elasticity (see also Fase and Spaans, 1980).

Most prices are determined by their cost factors, prices of foreign competitors and, if relevant, the utilization rate. The cost factors are constructed specifically for each price and consist of 4 component parts, *viz.* wage costs, costs of imports, energy costs and costs of capital. The equation for wages in industry includes the index of consumer prices used for wage indexation, labour productivity, a nonlinear Phillips curve and tax evasion as explanatory variables. Moreover, net social insurance contributions paid by employers make up the difference between wage costs and gross wages.

Government spending and revenues, resulting in the government deficit which plays an important role in the financial model, are endogenized in an elaborate submodel for the public sector. Apart from the usual technical equations for tax receipts, where taxes on profits from natural gas are considered separately, this submodel depicts the specific characteristics of the Dutch system of social security. It permits simulations to be run on changes in social insurance contributions and benefits in the light of discussions on austerity in public spending. The model also endogenizes interest charges on public debt which have become of much importance in recent years due to the accumulation of large bond-financed government deficits. This equation forms another major link with the financial sector. Finally the submodel for the real sector includes contributions and benefits of life assurance companies and pension funds.

As mentioned before, FREIA's submodel for the financial sector is a revised version of the monetary model published in Den Haan, Hasselman and Okker (1981). As advocated by Brainard and Tobin (1968) the model is based on a fully closed and therefore consistent set of balance sheets. Thus it reckons explicitly with the balance sheet restrictions and with the macro-economic equilibrium condition that the surpluses and deficits of the respective domestic sectors should add up to the balance of payments surplus or deficit. There are five sectors in the model, *viz.* government, central bank, banks, private sector and the foreign sector.

The private sector's financial surplus results from the macro-economic budget constraint and is calculated as the remainder of the balance of payment deficit or surplus, the government deficit, the exogenous financial surplus of the central bank and the surplus of the banks, which is related to the endogenous imputed bank service charges. In this way the private sector's financial surplus forms a major transmission channel from the real to the monetary sector.

Given the sectoral surplus, the composition of financial assets of the private sector is determined in three steps. Firstly the demand for short-term bank loans ensues from the tension between *ex ante* demand and supply in a disequilibrium approach. Credit ceilings set by the central bank as a monetary policy instrument may affect the *ex ante* supply. In the next two steps the financial wealth of the private sector is allocated according to a nested optimal portfolio model with interest rates as the main determinants. First comes the allocation of wealth over broadly defined liquid assets, net domestic bonds and equities, foreign bonds and equities and other net foreign assets. The second allocation model yields the composition of liquid assets over the component parts, *viz.* currency, demand deposits, time deposits and savings deposits at banks. The estimation procedure of the allocation models accounts for the balance sheet restriction so that there is no residual item. Moreover, the assumption of symmetry of the interest rate coefficients has put further restrictions on the parameter estimates.

Apart from short-term bank loans which, as mentioned before, follow from a disequilibrium approach, all other assets of banks are allocated according to a similar optimal portfolio model. These assets are unborrowed reserves, net foreign assets, short-term government debt and net domestic bonds and equities.

Monetary financing of the government deficit and changes in the Treasury's balance are exogenous in FREIA so that capital market borrowing by the government results as the residual item on the government balance sheet. The set of balance sheets is closed by making changes in gold and foreign exchange holdings the residual item on the balance of payments. Then, on the analogy of Walras' law for a system of markets in equilibrium, the balance sheet restriction of the central bank is automatically implied by the other restrictions. Hence, there is no residual item on this balance.

Both the short-term and the long-term interest rate are implicitly determined by market equilibrium. The short-term interest rate results from the equality of supply and demand of short-term government debt and the long-term interest rate follows from the equilibrium on the capital market. The other interest rates are determined as a weighted average of these two domestic interest rates or by foreign interest rates. The version of FREIA as published by Hasselman *et al.* (1983) has an exogenous exchange rate. However, the publication on the monetary model by Den Haan *et al.* (1981) gives, albeit as a digression, reaction functions for foreign exchange market interventions endogenizing the exchange rate.

2.2 *KOMPAS*

KOMPAS (compass) has borrowed its name not from German mythology but from navigation, a discipline of an even greater tradition in the Netherlands than macro-economic model building. KOMPAS is used as an acronym (and also anagram) of a quarterly (*k*wartaal) *mo*del for *p*rediction, *a*nalysis and

simulation. Whereas FREIA has primarily been designed for medium-term analysis, KOMPAS' main task is short-term analysis and forecasting. In this respect it is the successor of Driehuis' (1972) quarterly model of the Dutch economy, which still has the structure of the first generation Keynesian demand models with unemployment as the only cyclical indicator. Yet the structure of KOMPAS strongly resembles that of FREIA, providing it with the same simulation properties, so that it could also be used for medium-term analysis. However, for short-term analysis KOMPAS is more adequate than FREIA as it can describe developments within a year.

The capacity to foresee and analyse short-term fluctuations forms a major rationale for building a quarterly model. For example, an annual model may hardly reveal the J-curve effect in case of depreciation or appreciation. Moreover, institutional relations such as indexing of wages or the export price of natural gas following oil prices with a delay of half a year, can be translated much more adequately in a quarterly model than in an annual model. It is, by the way, remarkable that the authors of KOMPAS do not mention the availability of more data for estimation as an advantage of a quarterly over an annual model. As in FREIA, statistical estimation has not played a dominant role in assessing the parameter values in KOMPAS.

The model, which consists of 851 equations, is based on data over the period 1954:I–1975:IV for the real sector and over the period 1967:I–1978:IV for the financial sector. As a matter of fact, the sheer counting of the number of equations in KOMPAS greatly exaggerates the size of the model as all behavioural equations are split up into units giving the effect of only one explanatory variable at a time.

A major problem in building a quarterly macro-economic model for the real sector in the Netherlands is the lack of consistent quarterly data on the national income and expenditure accounts. For that reason the Netherlands Bank has, for its own model-building activities, constructed and published (De Nederlandsche Bank N.V., 1982) quarterly data partly derived from the annual data from the National Accounts of the Central Bureau of Statistics. These data have been used in estimating the Bank's quarterly model MORKMON. The monograph on KOMPAS does not provide much information on the method of construction of the quarterly data on which the model is based. Presumably, these data are constructed by the Central Planning Bureau itself.

As is obvious for a quarterly model, a lot of attention is paid to the dynamics of KOMPAS. The specification of the lag structure in the behavioural equations has never been identified by formal statistical or econometric procedures such as advocated by Box and Jenkins (1970) or by Hendry and others (see *e.g.* Hendry and Mizon, 1978, Hendry and Richard, 1983 and also Den Butter and Verbon, 1982). Instead, a selection of distributed lags with different weights and average lag-lengths has been posited. Then each explanatory variable for which a lagged reaction is in order obtains the distributed lag structure that seems most plausible from an economic point of view. Deliberately no Koyck

lags have been used for the justifiable reason that they hamper the attribution of effects to a specific variable. On the other hand, by representing partial adjustment the Koyck lag provides in many cases an adequate and economically elegant description of lagged reactions. Moreover it enables empirical determination of the average lag length. Therefore I would not completely favour the way in which the lag structure in KOMPAS is selected *a priori.*

As FREIA and KOMPAS mainly have the same structure, a full overview of KOMPAS is not needed here. Some differences, however, deserve attention. A small but remarkable divergence from FREIA is that in KOMPAS the tension on the market for short-term bank loans does not play a role as a monetary transmission variable in the equation for inventory formation. This makes the interest rate the only channel of monetary transmission in KOMPAS.

More substantial differences in specification with respect to FREIA occur in the financial submodel of KOMPAS. All interest equations are linearly homogeneous and the allocation of assets is exclusively determined by interest rate differentials. Consequently a general shift in interest rates does not affect the allocation of assets.

The parameters of the allocation models for the assets of the private sector and of banks are not, as in FREIA, estimated directly under the restrictions imposed by the accounting identity, but Don's (1982) method using 'spreaders' has been applied instead. All equations of the allocation model are freely specified and estimated, and the remainder is 'spread' over the component assets. An asset that, in this fashion, obtains a relatively large part of the remainder, performs the role of a buffer. This is, for instance, the case for net foreign assets of banks, which is in conformity with findings of others (see *e.g.* Den Butter, Fase and Huijser, 1979; Lindeboom, 1982) that in the short run banks react rather passively with respect to their net foreign assets. It is interesting to note that the first version of the monetary model by Den Haan *et al.* (1981) also used the method of spreaders, while FREIA returns to the more traditional method of estimation under restrictions. The latter method has a sound economic theoretical foundation. KOMPAS, however, advocates the use of the method of spreaders as it allows for a more flexible choice of the lag structure. In spite of these differences in specification of the monetary submodel between FREIA and KOMPAS, the working and numerical analysis of both models remains, as the authors assure, about the same.

Apart from the description of the equations and the working of the model, the monograph on KOMPAS provides valuable insight into the practical use of the model for prediction. This aspect, with which every practioner has to deal, obtains little attention in the literature on model building. Actually, relevant macro-economic predictions never ensue from the model in a completely mechanical way. All major forecasting institutions use both the consistency of their models and outside information for predictions. After assessing the values of exogenous variables, including the policy stance, outside information

is also introduced into the model by means of so-called add-factors or con-(stant) adjustments, which, according to Klein (1979), were already used in the 1950's when making predictions with macro-economic models. A scrutiny of recent single equation residuals may provide an indication of the size and pattern of these add-factors. Moreover the monograph on KOMPAS pays ample attention to the way in which preliminary and incomplete data are handled. This is a major problem when using a quarterly model, as final data, especially on the National Accounts, become available with a long delay. Yet the scattered, recent data can be consistently introduced into the model and may thus provide early information on still unobserved developments in other variables as well.

3 THE MODELS AT WORK IN POLICY ANALYSIS

3.1 *Simulations with FREIA*

Beside predictions, the main use of the Central Planning Bureau's models is simulation of the impact of proposals for economic policy. As mentioned in the introduction, FREIA's first simulation results were presented in a note of the Central Economic Commission in 1982, showing the effects of a reduction of the government deficit by 2% of net national product (NNP) yearly over the period 1984–1986. These results were remarkable as they differed substantially from the outcomes obtained with the earlier model VINTAF. The most appealing summary of the simulations was given in a graph that showed how the reduction of the deficit would lead in the short run to more unemployment with a maximum of about 30,000 man-years after 3 years, but unemployment would decrease thereafter with a negative effect after 6 years. The reversal of the effects of a reduction of the government deficit appeared to be even more marked in the case of investment in equipment. According to VINTAF such a restrictive fiscal policy would also lead to less employment and less economic growth in the long run.

Several other policy proposals have since been judged by FREIA. The monograph on FREIA shows a number of simulation results as well, from which three variants are selected in Table 1 in order to give some insight into the working of the model. Unfortunately no similar simulations are available for KOMPAS, but as the authors claim that that model has the same simulation properties as FREIA, the results of Table 1 should be representative for KOMPAS as well. The simulations are:

I A permanent rise in the volume of world trade by 1%
II An autonomous and permanent reduction of the wage level by 2%
III A permanent increase in the level of government expenditure by 0.5% of national income, equally distributed over government consumption of goods and services and over income transfers to households. These expenditures are financed by borrowing on the capital market.

The first simulation gives the effects of a change in a major exogenous

TABLE 1 – IMPULSE EFFECTS IN FREIA

Results* (cumulative changes from base line projection; in % unless indicated otherwise)	I Increase in the volume of world trade by 1%				II Autonomous reduction of wage rate by 2%				III Increase in government expenditure by 0.5% NNP (long-term financing)			
	effect of impulse after . . . years											
	1	2	4	9	1	2	4	9	1	2	4	9
Volume private consumption	0.1	0.1	0.2	0.2	−0.6	−1.3	−1.4	−1.1	0.3	0.4	0.4	0.3
Volume private investment in equipment	0.8	1.5	0.9	0.8	−0.9	−1.6	−1.7	2.8	0.9	1.6	0.4	−0.6
Volume exports of goods	0.7	0.7	0.7	0.8	0.2	0.5	0.8	0.9	0.0	−0.1	−0.1	−0.1
Volume production of enterprises	0.3	0.4	0.4	0.5	−0.1	−0.2	−0.1	0.4	0.4	0.4	0.3	0.1
Price private consumption	0.0	0.1	0.0	0.0	−0.8	−1.0	−1.1	−1.2	0.0	0.1	0.1	0.2
Unemployment (in 1000 man-years)	−6.3	−7.6	−8.0	−11.3	−3.7	−6.5	−18.1	−23.4	−6.7	−7.9	−6.3	−3.7
Current account balance of payments (in % NNP)	0.1	0.0	0.1	0.1	0.2	0.5	0.7	0.3	−0.3	−0.4	−0.3	−0.3
Financial surplus government (in % NNP)	0.1	0.2	0.2	0.3	0.0	0.0	0.2	0.7	−0.3	−0.3	−0.4	−0.7
Liquidity ratio (in % points)	−0.1	−0.2	−0.1	0.0	0.5	0.7	0.7	0.4	−0.2	−0.3	−0.2	−0.3
Long-term interest rate (in % points)	0.0	0.0	−0.1	−0.1	0.0	−0.1	−0.3	−0.5	0.1	0.1	0.2	0.4
Short-term interest rate (in % points)	0.0	0.0	0.0	0.0	0.0	0.0	−0.1	−0.3	0.0	0.1	0.1	0.1

* The results are reproduced from Hasselman *et al.* (1983).

variable and may, for instance, indicate how uncertainty about this variable would affect projections. Table 1 shows that a rise in world trade leads to more exports and hence to more investment and production of enterprises. The long-term impact multiplier with respect to production is about 0.5. As the increase in exports is almost completely matched by an increase in imports, the current account of the balance of payments improves only slightly. Therefore no substantial effects show up in the monetary variables such as the money stock and the interest rates. Obviously there is not much monetary transmission from these variables to the real sector of the economy either.

The other two simulations represent policy options. A reduction of the wage rate by 2% (simulation II) leads to a fall in private consumption which amounts to about 1.5% after 4 years. Because of this effect on demand and because of less scrapping of equipment due to a prolonged economic life, investment decreases considerably in the first year as well. However, after 4 years the rise in profitability fully compensates these negative effects and in the long run the level of investment surmounts the base line. Less scrapping to start with and more investment at the end yield an increase in employment, which is the main policy goal of a wage reduction. The current account of the balance of payments improves considerably due to enhanced competitiveness and, in the long run, the government deficit decreases because wage-related expenditure drops. This simulation has, therefore, much more impact on the financial sector than a rise in world trade has. The falling interest rates (mainly the long-term rate) contribute to the growth of investment.

In the short run an increase in government expenditure (simulation III) illuminates the standard Keynesian textbook case. Economic activity speeds up as illustrated by the increase in consumption, investment and production, and by less unemployment. However, in the second half of the simulation period reverse effects start to predominate. The worsening of the position of the balance of payments and the growing government deficit lead to higher interest rates. This results in a crowding-out of investment, which falls after nine years below baseline level. Consequently employment also decreases at the end of the simulation period, albeit that the final effect is still positive in this case.

The opposite of the latter simulation would represent a policy of reduction of the government deficit. Yet the simulation published in the note of the CEC (1982) seems to yield much more effective results, while the turning points with respect to investment and employment occur at an earlier stage. A reason for this is that in the CEC scenario the induced part of the reduction of the deficit after 1986 is used for stimulating demand by means of a tax cut. Moreover, this scenario assumes a somewhat different policy mix. The composition of the policy mix and the way it is translated into the model may affect the timing and efficacy of a policy of fiscal restraint. However, according to FREIA, such a policy will lead, regardless of its shape, to a stronger economic growth in the long run.

In this respect, as noted before, the simulation with FREIA differs considerably from the results obtained by the former policy model VINTAF. The divergency of results may have several causes. A first possible source of difference is the submodel for the real sector. Although this submodel of FREIA has the same structure as VINTAF, a number of specification changes have been made, such as the modelling of technical progress, monetary transmission and a further disaggregation of imports. However, tentative calculations and the description of this simulation in the monograph on FREIA suggest that the introduction of the financial submodel is the most likely source for the predominance of reverse effects in the long run. Moreover, the assumption of borrowing on the capital market contributes to the difference in outcome between FREIA and VINTAF. In the case of monetary financing the FREIA simulation shows more resemblance to the results obtained by VINTAF, albeit that this variant leads to a fast loss of foreign assets which would affect the (exogenous) exchange rate and therefore the interest rates in the long run. The latter mechanism has not yet been modelled in FREIA.

3.2 *A Comparison with Other Models*

A recent paper by Chan-Lee and Kato (1984) provides a comparison of the working of FREIA with a number of other policy models of OECD countries. In the case of a wage reduction FREIA yields, apart from the Australian model and the implausible effects for Denmark, the highest long-run impact on employment. The paper reveals remarkable differences between the models with respect to the effect on economic activity of this policy option. Only a minority of the models show, like FREIA, a sign reversal, with a negative impact due to a fall in demand in the short run, and a positive impact due to enhanced competitiveness and higher profits in the long run.

According to almost all models an increase in government expenditure of 0.5% of GDP has a positive impact on economic activity in the short run, which diminishes due to adverse effects in the long run, but remains positive throughout. Thus, these models are similar to FREIA and quite different from VINTAF in this respect, albeit that the final impact of FREIA (after 7 years) is the smallest of all models. The simulated effects on the interest rate differ widely amongst the models: according to the Treasury model for the United Kingdom the short-term rate increases finally by more than 3.5 percentage points whereas the final effect in the French model COPAIN is only 0.02 percentage points. Anyhow, the survey by Chan-Lee and Kato shows that FREIA gives very sensible simulation results as compared to other policy models in OECD countries.

4 SOME FURTHER ASPECTS OF THE MODELS

4.1 *The Vintage Approach*

The introduction of FREIA's predecessor VINTAF has evoked a vivid discussion amongst Dutch professional economists on the adequacy of that model for policy analysis. Since the main novelty of VINTAF as compared to the previous demand-oriented models is its vintage approach (see Den Hartog and Tjan, 1976) and since the policy recommendation of reducing wages in order to enhance employment stems from that approach, the discussion concentrated on this aspect. Suddenly the number of empirical and theoretical studies on vintage models ballooned in the Netherlands. This discussion is still relevant, as the supply blocks of FREIA and KOMPAS are, with some amendments as noted in section 2, copied from VINTAF.

Some major elements of the discussion are (see *e.g.* Driehuis and Van der Zwan, 1978)

1. The estimation procedure and the sensitivity of the policy analysis to the parameter values.
2. The presumption of a constant capital-output ratio.
3. The modelling of technical progress which, in VINTAF, is assumed to be embodied and labour-saving only.
4. The scrapping condition.
5. The aggregation into one macro-economic vintage model of capital-intensive and labour-intensive industrial sectors.

Re 1. The estimation procedure is challenged by Kuipers and Bosch (1976) and by Van Schaik (1976a). Both studies suggest alternative criteria to be minimized in order to obtain parameter estimates of the vintage model. These criteria, indeed, lead to different parameter estimates, which affect the working of the model to some degree but not fundamentally. A sensitivity analysis of Muysken and Van Ardenne (1976), however, suggests that the margins of uncertainty adhering to these estimates make the adequacy of the model for policy analysis questionable. The Central Planning Bureau itself has also experimented with the minimizing criterion as different criteria are used in various publications (see Den Hartog and Tjan, 1976, footnote 17 and Den Hartog, Van de Klundert and Tjan, 1975, Appendix A). FREIA minimizes the product of the root mean square error of the labour demand equation and the root mean square deviation of the capacity utilization rate from 90%. The study by Kuipers and Bosch, moreover, indicates the correspondence between the profit rate of the newest equipment and the growth of investment. This suggestion has been elaborated in FREIA by making the profit rate a determinant of new investment.

Re 2. The presumed constancy of the capital output ratio in particular and the adequacy of the clay-clay structure in general gave rise to a number of alternative empirical vintage models for the Netherlands, mainly of the putty-clay type (see Kuipers and Van Zon, 1982, and the references therein). These

exercises, however, did not lead to a complete abandonment of the clay-clay specification in FREIA. Yet, the equation in FREIA deriving productive capacity from the capital stock contains a constant term so that the mean capital output ratio differs from the marginal capital output ratio, implying that the average capital output ratio in FREIA is no longer constant.

Re 3. The specification of the vintage model of FREIA (and consequently KOMPAS) has changed as compared with VINTAF in yet another major aspect. Whereas in VINTAF labour-saving technical progress is completely embodied in the vintages, FREIA partly assumes, as noted in section 2, disembodied labour-saving technical progress as well. Such a change in specification is advocated by Kuipers, Muysken and Van Sinderen (1979) who estimate the technical progress to be embodied for about 75% and disembodied for about 25%. This result corresponds with the respective parameter values in FREIA over the period 1951–1975. Yet disembodying technical progress may influence the working of the model rather seriously. In a clay-clay vintage model with FREIA's (and VINTAF's) scrapping criterion, and with μ the rate of embodied technical progress, and ε the rate of disembodied technical progress, it can be shown that in case of steady-state growth, when the growth rate of real wage costs (λ) equals the rate of total technical progress ($\lambda = \mu + \varepsilon$), the economic life-span of equipment is constant and proportional to $1/\mu$. Therefore, given constant total technical progress, the assumption of disembodied technical progress implies a lower value of μ and hence a longer economic life-span than the assumption of all technical progress being embodied. Moreover, when the growth rate of real wages is smaller than the total rate of technical progress ($\lambda < \mu + \varepsilon$), the economic life-span of equipment increases each year by $(\mu + \varepsilon - \lambda)/\mu$. Thus the more the technical progress is assumed to be disembodied, the larger is this increase, and the older are the vintages to be scrapped. Hence the assumption of disembodied technical progress may have a substantial impact on the composition of the capital stock implied by the model.

Re 4. Following Malcomson (1975), Den Butter (1976) has suggested an alternative scrapping criterion in a clay-clay vintage model. According to this criterion, producers will, when maximizing their profits in a situation of imperfect competition, not postpone the scrapping of equipment until output falls below labour costs, but will scrap earlier, when new equipment becomes more profitable than old equipment. In this criterion capitalization of the new equipment and hence capital costs play an important role, providing another possible channel of monetary transmission. Driehuis, Heineken and De Savornin Lohman (1979) have incorporated such a criterion in an empirical vintage model for the capital-intensive industrial sectors in the Netherlands and conclude that capital costs have been of equal importance as labour costs for the development of employment.

This suggestion for an alternative scrapping criterion including capital costs has not been adopted by FREIA. Neither has the proposal of Van Schaik

(1976b) been incorporated. He makes the scrapping of old equipment dependent on the utilization rates of both capital and labour.

Re 5. The problem of aggregation is studied extensively by Den Hartog and Tjan (1980; see also Tjan, 1984). They estimate clay-clay vintage models for nine sectors of industry in the Netherlands, allowing for a much broader specification than the original model (Den Hartog and Tjan, 1976) which forms the supply block of VINTAF. Apart from the usual embodied labour-augmenting technical progress the sectoral vintage models include parameters for embodied capital-augmenting technical progress and disembodied labour-augmenting technical progress. The estimation results of the sectoral vintage models lead Den Hartog and Tjan to a reformulation of the macro vintage model which is almost identical with the specification in FREIA. The projections of employment with this aggregated model compete fairly well with the aggregated projections of the sectoral models. Moreover, the reformulated macro model yields an adequate description of the development of employment in the postwar years preceding 1959. The failure on this point has been a major criticism of the original vintage model of Den Hartog and Tjan. Thus the authors conclude that their study gives support to the application of the vintage model on the macro level. Although this conclusion may remain questionable with respect to some details of the approach, the Central Planning Bureau's modelling of the supply block by means of a clay-clay vintage model has evoked much creativity of practical relevance amongst the Dutch economic profession. Moreover, it has led to improvements of the specification of the supply block in FREIA as compared with VINTAF.

4.2 *Modelling the Financial Sector*

Apart from the criticism of the vintage model, the major objection to VINTAF, of course, was the absence of financial relationships. Filling this gap can be regarded as the main achievement of the new models FREIA and KOMPAS. Yet it by no means marked the start of empirical modelling of the financial sector in the Netherlands. Following a theoretical study of Korteweg (1971), Van Loo (1974) and Korteweg and Van Loo (1977) estimated small models for the Dutch financial sector. Knoester (1979, 1980) integrated his monetary model (Knoester, 1974) with a model of the real sector. These models are all inspired by American monetary theory and attribute a dominant role to the money supply and the corresponding multiplier effects. Monetary base is regarded as an indicator of monetary policy and, by Knoester, also as a channel of monetary transmission. This is rather curious as the Netherlands Bank has never used the monetary base in policy analysis nor found empirical evidence for its relevance. The latter is illustrated by studies of Dongelmans (1977) and Fase (1980) which do not reveal much stability in the relationship between monetary base and the money supply. It seems, therefore, justifiable that the monetary base does not play any role in the recent models of the Central Planning Bureau. In this respect American monetary theory may refer

to the specific system in that country, but should not be applied blindly to other countries.

In the 1970's members of the research staff of the Netherlands Bank published a number of empirical studies on financial relationships. These studies resulted in the construction of the quarterly model MOKMON (see Fase, 1981 and the references therein). As noted before, almost at the same moment the Central Planning Bureau gave birth to the annual monetary model (Den Haan *et al.*, 1981) which is, in a slightly revised version, included in FREIA.[1] A third fully fledged model of the Dutch monetary sector has been constructed by Van Loo (1983). The latter is also a quarterly model and provides a disaggregation of the balance sheet of the private sector into sectoral balance sheets for institutional investors, mortgage banks, corporations and households.

A striking difference with MOKMON and Van Loo's model is the disequilibrium approach in FREIA and KOMPAS for the market for short-term bank loans. Kooiman and Kloek (1979) give the theoretical foundations for their approach, which is followed in FREIA and KOMPAS, in the labour market and the application to that market seems justified. However, there is not much reason to model the market for short-term bank loans in a different way than the other financial markets, where an equilibrium approach is applied. Besides, if in a closed system of markets, which is explicitly the case in the monetary model, one market is in disequilibrium, this would lead, according to Barro and Grossman (1971), to a spillover of the disequilibrium to the other markets. I would therefore prefer the description of the market for short-term bank loans in the Bank's model MOKMON (and consequently the integrated model MORKMON), where following Fase (1979) the amount of bank loans granted is demand-determined and the interest rate results from the price-setting behaviour of the banks.

Another problem resides in the choice of the financial assets explained in the allocation model of the private sector. With respect to savings deposits FREIA and KOMPAS only consider savings deposits with banks, whereas in the model of the Bank and in Van Loo's model savings deposits at banks and at savings banks are taken together in the allocation model. The latter is preferable as there is virtually no difference to holders of savings deposits, whether the deposits are at banks or at savings banks. Moreover it would be correct to include savings deposits at savings banks in M3 as monetary aggregate. In the Central Planning Bureau's model these savings deposits are not included in M3.

A related question concerns the choice in FREIA and KOMPAS for *net* domestic long-term assets as part of the portfolio of the private sector to be explained by the allocation model. The Bank's model considers the long-term assets and the long-term liabilities of the private sector separately and, in

1 For a comparison of the monetary models of the Central Planning Bureau and the Bank, see Duisenberg (1984).

addition, does not consolidate the long-term assets of the institutional investors in the balance sheet of the private sector. This allows the introduction into the model of a behavioural equation for the demand for long-term credit by the private sector, linking this important source of financial assets with the appropriate scale variables from the real sector such as housing stock for the demand for mortgages (see Den Butter, Dongelmans and Fase, 1977) and industrial investment for the demand for long-term credit by enterprises. A net approach prohibits such a scaling.

A final observation relates to the implicit determination in FREIA and KOMPAS of the short-term interest rate on the market for short-term government debt. In recent years this market has hardly been relevant for determining the short-term interest rate, which resulted mainly as the consequence of the so-called 'narrow monetary policy' of the Netherlands Bank, *i.e.* the money market and exchange market policy. The Bank's model explains the short-term interest rate along these lines by a policy reaction function. On the other hand, the modelling of the portfolio behaviour of banks in FREIA leads to an implicit determination of the long-term interest rate as well, whereas MORKMON explains the long-term interest rate in a kind of reduced-form equation of supply and demand on the capital market. The latter approach may disguise changes in the interest rate due to structural shifts on the capital market.

5 CONCLUSION

The new macro-economic policy models of the Central Planning Bureau, FREIA and KOMPAS, have not altogether been born under a lucky star. At present the usefulness of large macro models is severely challenged both by policy-makers and by economic academics. The seemingly poor performance of the models in foreseeing the events of the past economic crises evidently disappointed a lot of users of these models. Another recent complaint of policy makers is that, according to the models, no policy measure may produce enough effect in order to curb the present economic trend. The models are even labelled 'policy resistant.' Economic theory raised the so-called Lucas critique (see Lucas, 1976; Lucas and Sargent 1978) against the large (Keynesian) policy models. This critique questions the structural independence of the models in regard to policy measures.

Of course there is some truth in this criticism as empirical macro-economic models are not omnipotent and their structure can necessarily only be based on past experience. Obviously, a model is unable to simulate the effects of a policy measure that cannot be translated into the model in an appropriate way, for instance, as it relates to meso-economic or micro-economic behaviour. Yet this review of FREIA and KOMPAS demonstrates that at several places the structure of these models has been adapted to the specific needs of actual policy analysis. Examples are working-time reduction, social security expendi-

ture and investment stimulation. Besides, as compared to major policy models of other countries, there are no signs of FREIA picturing a particularly policy-resistant image of the economy.

The Lucas critique has produced a large amount of predominantly theoretical substitutes for the traditional macro-economic models. However, its empirical offshoots, such as Sargent's (1976) rational expectations equilibrium model, Barro's (1977, 1978) reduced-from equations or Sims' (1980, 1981) vector autoregressive processes, do not present an alternative which would be very useful for the Dutch policy makers accustomed to the Central Planning Bureau's analysis. Yet the emphasis that the new classical macro-economists lay on the role of expectations provides a lesson to be learned. FREIA and KOMPAS, like most of today's policy models, hardly pay attention to the formation of expectations. This aspect seems worthy of further evaluation especially as the reaction to an expected change may be anticipated and therefore differ from the reaction to an unexpected change.

As is explicitly stated by the authors, FREIA and KOMPAS are not based on a general theoretical framework from which all equations are derived. Instead, they are more or less pragmatically shaped, selecting for each behavioural equation the most appropiate and economically most plausible specification. Therefore, the models are made to reflect current thought on the working of the economy in the Netherlands in a documented and consistent way. As such, they do not give deliberate support to a theoretical or a political *a priori*. Moreover, the model consistency allows a policy-maker who disagrees with the results of a model to indicate where his *a priori* differs from the specification of the model. This enables empirical investigation of the objection so that unfounded prejudice may be ruled out of the policy analysis.

FREIA and KOMPAS can be regarded as worthy heirs in the rich tradition of the Central Planning Bureau's use of macro-economic policy models. This tradition will certainly survive the temporary upsurge of criticism, if only the model builders remain susceptible to useful suggestions from economic and econometric theory and to the needs of policy practice. Mythology tells about the goddess Freia's falcon-feathered dress, which enables her to change and correct her figure as she wishes. This seems a neat property for a model as well, as long as it is used with moderation and not abused to serve political purposes. In the latter case a model would no longer be a reliable compass for policy analysis.

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Summary

FREIA AND KOMPAS, THE CENTRAL PLANNING BUREAU'S NEW GENERATION OF MACRO-ECONOMIC POLICY MODELS: A REVIEW ARTICLE

On the eve of the 50th anniversary of macro-economic model building in the Netherlands, the Central Planning Bureau introduced two new models for policy analysis, the annual model FREIA and the quarterly model KOMPAS. The main novelty of these models as compared to their predecessors is a fully fledged submodel of the financial sector. This review article highlights some features of both models and compares their properties with those of other models and with results from the literature. The models have been explicitly constructed for practical use and therefore do not reflect any theoretical approach in particular.